

Presented at the Advanced Turbine Systems Annual Program Review
Morgantown, WV October 28-29, 1997

The Gas Turbine Association: An Update

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Abstract

The Gas Turbine Association (GTA) was founded in 1995 as a trade association with the mission of promoting the interests of the gas turbine industry. Member companies include original equipment manufacturers, suppliers of parts or services, and other organizations with some stake in the gas turbine industry. This paper presents the accomplishments of GTA since the last ATS Annual Review in November, 1996. Some of the accomplishments are summarized as follows.

In the area of government support for gas turbine R&D, the GTA Technical Affairs Committee met with key congressional staffers to present GTA's R&D recommendations. Full budgetary support for the ATS Program is first on the agenda, followed by the Flexible, Midsize Gas Turbine (FMGT) Program. The FMGT is in a size range not covered by the ATS Program (30-150 MW) and is intended for the midrange power market with first cost only slightly higher than a frame type simple cycle of the same size, an efficiency in the mid to high 40's percent, and the capability to make many cold starts to full load within 10 minutes without a significant decrease in life. GTA worked with DOE and the California Energy Commission (CEC) to have a planning workshop for the FMGT Program. The workshop was held in Sacramento, CA sponsored by DOE and CEC. Co sponsors were GTA, EPRI, the Gas Research Institute (GRI), and the Collaborative Advanced Gas Turbine Project (CAGT).

The Environmental Affairs Committee held two meetings with EPA officials, promoting regulatory policies which encourage the use of gas turbines. This will reduce emissions generally compared to the current generation mix which is heavily dependent on steam plants with much higher emissions than gas turbines.

The Market Affairs Committee organized a forum on the issues involved with insuring and financing of gas turbine projects. Recommendations came from this forum on how manufacturers, project developers, owners, and insurers can work together effectively to improve the process of obtaining insurance and financing for gas turbine projects.

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Mission and Objectives

The Gas Turbine Association (GTA) was founded in 1995 to promote the interests of the gas turbine industry (figs. 1&2). The Association develops and advocates policies and practices that grow the market for gas turbines. GTA educates the government and general public regarding the economic and societal benefits of gas turbines.

GTA's objective (figs. 3&4) is to achieve recognition by the public and appropriate government agencies that gas turbines and combined cycles are high efficiency, environmentally responsible and a low cost way of generating electric power, mechanical drive, and cogenerated heat. It is important that the public and the government understand that the gas turbine industry provides the most efficient, low cost, clean energy available to meet our domestic needs, improve our energy security, reduce consumer energy costs and increase economic growth. If the industry delivers this message, Congress will support technology R&D, and federal and state regulators put in place rational emissions regulations for gas turbines. To accelerate worldwide market expansion, GTA is encouraging the availability of export financing for gas turbines, promoting free trade and a competitive US electricity market, and encouraging policies that will result in an adequate supply of insurance for gas turbine projects. Finally, GTA is becoming a clearinghouse for gas turbine information that is not readily available from other sources.

Membership and Structure

GTA is a classical trade association with member companies who pay dues to support a paid staff in Washington. Member companies (fig. 5) represent original equipment manufacturers, suppliers of parts or services, and other organizations with some stake in the gas turbine industry. This spring, GTA sponsored an Allied Interest Forum to focus on the interests of suppliers of goods and services to gas turbine manufacturers. The forum resulted in a constructive dialogue between OEMs and suppliers.

While GTA is governed by a Board of Directors, the Association's standing committees provide forums for members to discuss industry issues with colleagues from competing companies and allied organizations (fig. 6). Through these forums, committee members determine strategies for speaking with one voice on important issues.

Committee Accomplishments

The following activities highlight the true value of the industry trade association. These activities clearly show a unified gas turbine industry voice communicating on critical issues can have a positive impact on the financial success of GTA member companies (fig. 7).

Karen Weaver of Westinghouse currently chairs the Environmental Affairs Committee (fig. 8). The Committee's mission is to develop and implement a strategy for ensuring reasonable and responsible environmental practices. The Committee provides a forum to identify opportunities for the exchange of opinions between GTA members, government agencies and other allied interest groups. Through the members of the Environmental Affairs Committee, industry is communicating the environmental benefits of gas turbines to ensure reasonable emissions levels for all sizes of machines.

The Committee is conducting a series of educational seminars focusing on the environmental benefits of gas turbines. This year, the Committee members had several meetings with officials of the EPA Office of Air Quality Planning and Standards (OAQPS) and Office of Air & Radiation (OAR). GTA and EPA discussed the advantages of gas turbines over other power generation options when comparing emissions, efficiency and economics. GTA pressed the importance of developing a regulatory climate that encourages rather than discourages the use of clean efficient gas turbine power plants in new and retrofit installations.

John Bobrowich, Siemens Power Corporation, chairs the Market Affairs Committee (fig. 9). The Committee is charged with assessing the state of the gas turbine industry and communicating the importance of the industry to the U.S. economy. The Market Affairs Committee evaluates the impact of energy and utility regulatory policy on the gas turbine industry. International trade and export financing issues, which promote worldwide expansion of the gas turbine market also, fall under the jurisdiction of the Committee.

In 1997, the Committee continued its effort to promote the availability of insurance for gas turbine power plants. The Market Affairs Committee organized a forum in the financial district of New York City on the issues involved with insuring and financing of gas turbine projects. The meeting was a follow-up to the meeting earlier in Washington that had an overflow crowd on the subject of insuring gas turbine projects.

Recommendations came from this forum on how manufacturers, project developers, owners, and insurers can work together effectively to improve the process of obtaining insurance and financing for gas turbine projects (figs 10-12).

GTA's Government Affairs Committee, chaired by John Gruver of Westinghouse, focuses on increasing government recognition and support of the gas turbine industry (fig. 13). The Committee develops position papers and conducts meetings between member companies and federal, state and local officials. Government Affairs Committee educates

policy makers on applications and advantages of gas turbines, and advocates positions of interest on legislative and regulatory proposals. This group implements recommendations from the Environmental, Technical and Market Affairs Committees.

In 1997 the Committee continued its communications effort meeting with: 1) key House and Senate Interior Appropriations Subcommittee members and staff to discuss Fiscal Year 1998 R&D funding; 2) key DOE officials to recommend future R&D programs; and 3) government officials with jurisdiction to discuss electric industry deregulation efforts (fig. 11). The Government Affairs Committee has also stepped up its efforts to increase the impact of its industry grassroots network.

The GTA Technical Affairs Committee is chaired by William Day of United Technologies Corporation. This committee develops recommendations for government-supported technology R&D programs. In addition to the current Department of Energy (DOE) Advanced Turbine Systems (ATS) Program, the Committee examines new opportunities for government/industry partnership programs to move the state of gas turbine technology forward (fig. 14). The Committee also provides an industry forum to develop industry technical guidelines needed to increase the understanding and utilization of gas turbine engines.

In March 1997, GTA assisted the DOE and the California Energy Commission in putting together a program-planning workshop on the subject of a Flexible, Midsize Gas Turbine (FMGT). The purpose of the workshop was to bring together a broad cross section of knowledgeable people to discuss the potential benefits, markets, technical attributes and development costs. The Committee is also examining the common R&D needs of small turbine manufacturers as they move toward expanded opportunities in the distributed generation market.

The Technical Affairs Committee, in addition to its work in support of government/industry R&D programs, has begun working with the American Boiler Manufacturers Association (ABMA). In a joint technical meeting in May, the committees determined that the areas in which joint efforts can be beneficial are performance measurements of combined cycles, technology development, and environmental concerns. ABMA's guidelines for performance measurement of combined cycles are now under review by GTA members.

Finally, in the last year technical papers representing the gas turbine industry were presented at the Energy Daily conference on restructuring R&D in the electric power industry and at the Institute of Gas Technology conference on gas and electric power.

R&D Recommendations & Accomplishments

In the area of R&D funding, the Technical Affairs Committee met with the chief staffers for the House and Senate Appropriations Committees and discussed our recommendations for federal support of R&D funding (fig. 15).

Continuing the DOE Advanced Turbine System (ATS) Program at original funding levels for industrial (<20MW) and utility (>300 MW) size gas turbine technology development and demonstrations;

Extending the DOE/gas turbine industry R&D partnership to mid-size (30-150 MW) gas turbines to meet intermediate power market requirement for repowering and distributed generation;

Evaluating further advances in gas turbine technologies in combination with fuel cell technologies to achieve very high efficient clean hybrid power systems;

Extending gas turbine environmental technologies to ensure compatibility with new emission regulations; and

Expanding the alternate fuels flexibility of gas turbines to burn fuels of lower quality and waste energy resources.

As mentioned above, the FMGT initiative is aimed at a size range not covered by the ATS Program and at the intermediate load power market. GTA worked with DOE and the California Energy Commission (CEC), as well as EPRI, the Gas Research Institute (GRI), and the Collaborative Advanced Gas Turbine Project (CAGT) to hold a workshop on the FMGT Program in Sacramento on March 3-4 (fig. 16).

The participants in the workshop included representatives from the sponsoring organizations, electric utilities, gas utilities, independent power producers, gas turbine manufacturers, gas turbine packagers, and consultants knowledgeable in the power generation field. A total of 13 presentations were made on the technical and commercial aspects of the subject, followed by informal breakout sessions which dealt with sets of questions on markets, technology requirements, funding sources and cost sharing, and links to other programs. Following the breakout discussions, leaders of the breakout sessions reported to the whole group and discussed conclusions. The consensus of the overall group on the major subject areas was as follows.

The attributes needed for the gas turbine are shown in figure 17. This gas turbine would be intermediate in size between the very large utility and small industrial size gas turbines of the ATS Program and would be intended for intermediate capacity factor applications as well as repowering of existing steam plants via feedwater preheating. It would be a low

capital cost unit capable of rapid start to full load and able to take many load cycles without a significant reduction in life.

A key target market for the FMGT (fig. 18) is the more than 120,000 MW of aging oil and natural gas fired cycling steam plants in the United States, which will need to be replaced in the post-2000 time frame. California, New England, Mid-Atlantic States, Florida and Texas have among the highest concentration of such plants. Competition from wholesale power marketing, retail wheeling, and the requirement for environmental upgrades could accelerate the retirement of these units.

The market value of on-peak and intermediate load power in the United States is forecast to grow at a rapid pace while prices for off-peak power is anticipated to remain low, due to excess amounts of base load power. The higher value indicates the need for an FMGT with costs significantly lower than those of a combined cycle

Support for the development of the FMGT was shown to be very broad at the workshop including all regions of the US for a wide range of central, distributed, repowering and renewable applications by electric utilities, IPP's, municipal utilities, industrial self-generators and energy market companies. Strong market support was shown from Europe and Canada and demand for FMGT was also forecast to be significant in Asia.

A good candidate to meet the requirements of the FMGT Program is the intercooled aeroderivative, or ICAD (fig. 19). The intercooling between the low pressure and high pressure compressors reduces the work of compression and permits higher mass flow to be passed through the compressors. The intercooling also results in lower temperature at the compressor discharge, which makes turbine cooling air cooler, allowing higher turbine inlet temperature. The combination of these effects provides about twice the output of the comparable simple cycle, which enables low \$/kW. Using the largest and most efficient turbofans as the aircraft engine basis for the ICAD, the efficiency is increased to the mid to high 40's percent, which in combination with the low \$/kW makes the ICAD competitive at midrange capacity factor.

The exhaust temperature of an ICAD is low due to its high-pressure ratio. The most likely application of an ICAD in which heat recovery is required is in feedwater preheating, which can be used to extend the life of aging oil and gas fired cycling steam plants.

The original idea in fulfilling these market needs came from the Collaborative Advanced Gas Turbine Program (CAGT), launched in 1992 by a group of electric and gas utilities led by Pacific Gas & Electric and subsequently led by EPRI before spinning off in its present form as a freestanding program. In Phase I of the CAGT Program, each of the major aircraft engine manufacturers, Pratt & Whitney, GE, and Rolls - Royce, studied advanced gas turbines derived from their largest and most advanced aircraft engines. All three manufacturers concluded that the most attractive product and program beyond currently available simple cycles would be the development of ICAD's.

Another candidate is the Cascaded, Humidified Advanced Turbine, or CHAT (fig. 20). The CHAT cycle could be applied to either aeroderivative or frame - type gas turbines. The CHAT cycle can vary considerably in output depending on the size of gas turbine that is used as a basis for the plant. As with the ICAD, the CHAT strives to provide rapid response to load demand, low \$/kW cost, and high efficiency. As seen in fig. 20, the CHAT cycle does not use a heat recovery steam generator but instead uses a recuperator.

A private-public partnership is required (fig. 21) to make the FMGT available to end users, due to the high development cost and risk confronting gas turbine manufacturers. The plan for public funding is to seek funding from the California Energy Commission in the near term, while ATS requirements would prevent significant funding from being available from DOE. Then DOE funding is sought, starting small in FY99 and 2000, and growing in later years. The development effort should include a university R&D program as an extension of the one currently underway in the ATS Program, which is viewed as a highly effective approach to facilitate and manage university R&D work.

A steering committee for the FMGT Initiative was set up, including representatives from the sponsors of this workshop. The committee will set the program characteristics and work to gain the required support from the public and private entities that is required to launch the program.

Summary

In summary, (fig. 22) GTA is helping to advance the cause of gas turbines - - as a technology and as an industry. The Association develops and advocates policies and practices that grow the market for gas turbines. GTA communicates the government and general public regarding the economic and societal benefits of gas turbines. Most importantly, GTA's committee actions have a positive impact on the member companies' bottom lines.



Gas Turbine Association

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Mission Statement

Promote the interests of the gas turbine industry by:

- ◆ Advocating government support of gas turbine technology development
- ◆ Advocating rational emission regulations
- ◆ Educating the government and general public regarding the economic and societal benefits of gas turbines

Strategic Objectives

- ◆ Represent the gas turbine industry before Congress and federal agencies in order to secure government support of research and development and to secure rational emissions regulations.
- ◆ Achieve recognition by government agencies that gas turbines are a high efficiency, environmentally responsible and low cost way of generating electrical power, mechanical drive power and cogenerated heat.

Strategic Objectives

- ◆ Promote worldwide market expansion by encouraging the availability of export financing for gas turbines and promote the interests of the industry on international trade issues.
- ◆ Act as an industry clearinghouse for information on gas turbines.

Member Companies

ABB Power Generation Inc.

CAGT LLC

Catalytica Combustion Systems Inc.

CIGNA Property & Casualty

Combustion Turbine Technologies Co.

Electric Power Research Institute

Fluor Daniel, Inc.

Hartford Steam Boiler

Johnson & Higgins

Penn Well Publishing

Protection Mutual Insurance Co.

Rolls-Royce Inc./Allison Engine Company

Sermatech

Siemens Power Corporation

South Carolina Energy Research & Development Center

Strategic Power Systems

United Technologies Corporation

Westinghouse Electric Corporation

GTA Organization

Board of Directors

Standing Committees

Environmental Affairs

Market Affairs

Government Affairs

Technical Affairs

1997 Accomplishments

- ◆ Implemented public affairs campaign to establish GTA as *Voice of the Gas Turbine Industry*.
- ◆ Advocated R&D recommendations to Congress and the administration.
- ◆ Conducted meetings with EPA to promote GTA recommendations on emissions regulating.
- ◆ Conducted Forum on insuring and financing Gas Turbine Projects.
- ◆ Conducted allied interest forum with suppliers to gas turbine OEM's.
- ◆ Developed working with ABMA on issues of common interest.

Environmental Affairs Committee

- ◆ Develop an overall environmental strategy for the gas turbine industry.
- ◆ Identify areas where common principles regarding a reasonable regulatory environmental framework can be developed for use by the Government Affairs Committee.
- ◆ Address key environmental barriers, issues and opportunities as needed.
- ◆ Identify opportunities for synergy between GTA, government agencies and other allied interests.
- ◆ Provide an industry forum to facilitate communication of environmental issues affecting the gas turbine industry.

Market Affairs Committee

- ◆ Develop situational analyses addressing the state of the gas turbine industry and determine industry policies which promote worldwide expansion of the gas turbine market.
- ◆ Investigate and develop analyses of the impact of energy and utility regulatory policy on the gas turbine industry.
- ◆ Develop materials to promote the advantages of gas turbines and combined cycle power generation.
- ◆ Provide an industry forum to facilitate communication of market issues affecting the gas turbine industry.

GTA Conference on Insurability of Gas Turbine Projects

Issues Concerning Insuring and Financing New Projects

- ◆ New technology is demanded by owners and project developers to be competitive.
- ◆ GT's have become prime reliant base load systems, not just peakers.
- ◆ GT's projects are getting bigger and require insurance for business interruption, so insurance requirements are greater.
- ◆ Despite high overall reliability and availability, some large losses have raised concerns by insurers.
- ◆ Many IPP's have reduced redundancy, spare parts, and operator training, which increases risks of unavailability.

GTA Conference on Insurability of Gas Turbine Projects

Suggested Approaches to Address Issues

Manufacturers:

- ◆ Thorough and intense application of state-of-the-art analytical tools (e.g., failure mode and effects analysis)
- ◆ Extensive development testing with diagnostic instrumentation and fleet leader units. EPRI durability surveillance program has helped on new large GT's.
- ◆ Work with insurers during the development process to address “hot button” questions.
- ◆ Timely reporting of events to owners and insurers.

GTA Conference on Insurability of Gas Turbine Projects

Suggested Approaches to Address Issues (Cont'd.)

Project Developers/Owners:

- ◆ Work with insurers as the project is being defined, to assure appropriate actions to mitigate risk.
- ◆ Work with manufactureres to gather reliability data, including specialized instrumentation and inspections for early units.
- ◆ Make adequate training of GT operators an ongoing commitment.
- ◆ Plan for maintenance actions to reduce downtime.
- ◆ Have adequate amount and scope of spare parts, and support pools of spare parts between owners.

Government Affairs Committee

- ◆ Increase government recognition and support of the gas turbine industry.
- ◆ Educate policymakers on applications and advantages of gas turbines and advocate positions of interest on legislative and regulatory proposals.
- ◆ Implement recommendations from the Environmental, Technical and Market Affairs Committees.
- ◆ Provide an industry forum to facilitate communication of government issues affecting the gas turbine industry.

Technical Affairs Committee

- ◆ Develop recommendations and plans to secure government support of technology R&D programs as well as the Department of Energy Advanced Turbine Systems (ATS) program.
- ◆ Provide pre-competitive technical expertise and information to increase utilization of gas turbine engines.
- ◆ Assist other Standing Committees on key programs.
- ◆ Provide an industry forum to facilitate communication of technical issues affecting the gas turbine industry.

GTA Recommendations for Government-Supported R&D

- ◆ Continue to support the ATS Program at original funding levels for large (> 300 MW) and small (< 20 MW) gas turbines and combined cycles.
- ◆ Support development of flexible mid-size (30-150 MW) gas turbines for intermediate load, repowering and distributed generation.
- ◆ Evaluate fuel cell/gas turbine combination.
- ◆ Develop standard methods of correcting emissions data from site to standard conditions.
- ◆ Testing of alternative fuels (e.g. land fill gas and refinery off-gases).

Flexible, Midsize Gas Turbine (FMGT)

- ◆ Planning workshops held in Sacraments, CA March 4-5, 1997.
- ◆ Sponsors: US Department of Energy and the California Energy Commission
 - Co-sponsors: GTA, EPRI, GRI, CAGT Project.
- ◆ Other Participants: Electric utilities, gas utilities, independent power producers, gas turbine manufacturers/packagers, power generation consultants.

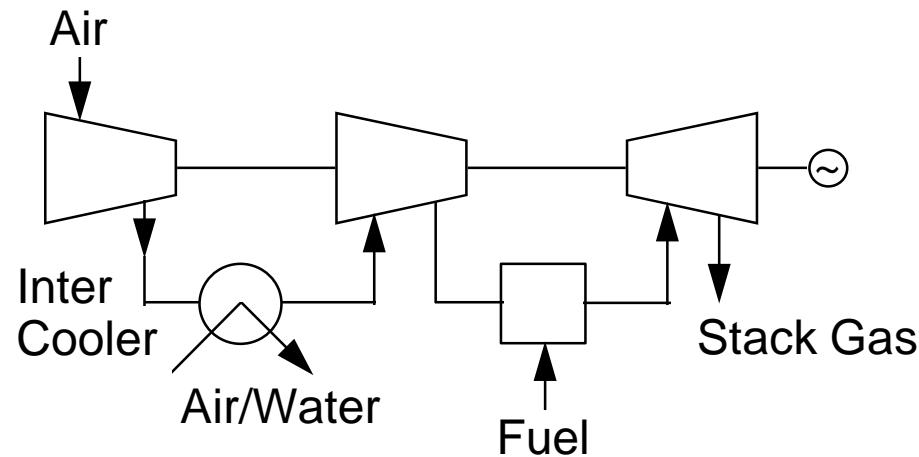
FMGT Attributes

- ◆ 30-150 MW size range -- not covered by the ATS program.
- ◆ Designed for mid range power -- 500-5000 hours per year
 - Efficiency in mid to high 40's percent
 - Cost (\$/KW) closer to a large, frame type simple cycle than to a combined cycle.
- ◆ Designed for cyclic duty
 - Cold start to full load in 10 minutes
 - Able to take many full load start-stop cycles without significant reduction in useful life.
- ◆ Designed for partial repowering of existing steam plants to improve competitiveness without investing in a full repowering project.

FMGT Applications

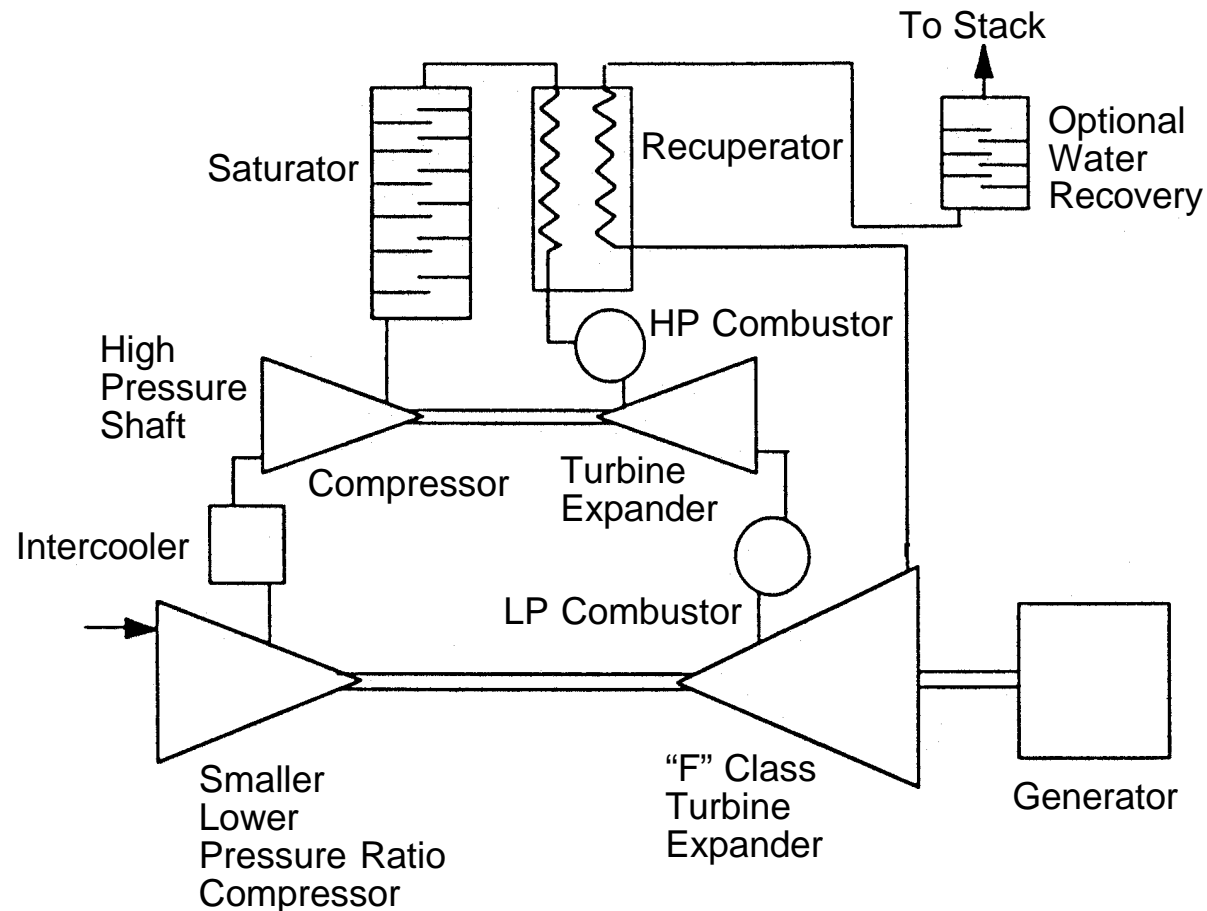
- ◆ Providing on-peak power at competitive costs, 500 to 5000 hours/year
- ◆ Repowering of more than 120,000 MW of aging oil and gas fired cycling steam plants in the U.S.
- ◆ Feedwater heating repowering of steam plants with modern steam condition.
- ◆ Interaction with smaller capacity renewable power sources (biomass, solar, geothermal) to make them competitive in a deregulated environment.
 - 10,000 MW of PURPA steam plants currently operating on renewable fuels.

Gas Turbine Technical Trends: Intercooled Aeroderivatives (ICAD)



- ◆ Twice the output of simple cycle -- Low \$/kW
- ◆ Efficiency in mid to high 40's % -- Competitive at midrange capacity factor
- ◆ Rapid start to full load -- Quick dispatch to meet fluctuating load

Gas Turbine Technical Trends: Cascaded Humidified Advanced Turbine (CHAT)



FMGT Development Approach

- ◆ Private-public partnership.
- ◆ Near-term public funding from CEC, 1998-01
- ◆ Longer term public funding from DOE, 1999-04
- ◆ Continued technology base funding by DOE
 - currently R&D programs
- ◆ Full scale testing by 2003

Summary

**GTA Is Helping Advance the Gas Turbine
Industry and the State of the Art of Gas
Turbine Technology**